DOCUMENT RESUME

ED 208 595 EA 014 178

TITLE	Energy Use in Community Schools. A Report.
INSTITUTION	Council of Educational Facility Planners, Columbus, Ohio.; National Community Education Association, Flint, Mich.
SPONS AGENCY	Mott (C.S.) Foundation, Flint, Mich.
PUB DATE	80
NOTE	32p.
AVAILABLE FROM	CEFP, 29 West Woodruff Ave., Columbus, OH 43210 ($4.50).
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Community Schools; Elementary Secondary Education; *Energy Conservation; *Extended School Day; Facility Utilization Research; *Fuel Consumption; Measurement Techniques; Research Methodology; School Community Relationship; School Schedules
IDENTIFIERS	Buehrer (Huber); *Energy Audits; Public Schools Energy Conservation Service

ABSTRACT

During the winter many schools have closed, or been considered for closing, in efforts to save energy. This study assesses and analyzes the impact on energy consumption of operating school facilities on an extended-day and evening basis compared with closing facilities for specified periods. The two variables examined are the extended-day program and building occupancy. The computer-based Public School Energy Conservation Service (PSECS) program is used in an analysis of data from 1,462 Ohio schools; and the manual methodology developed by Huber Buehrer is used in detailed energy analyses of four Ohio schools. The differences in the methodologies are discussed and findings from both methods summarized separately both in text and tables. A glossary is included at the end of the report. Practical applications of these findings include the following: (1) the school and the community should be viewed as a single energy-use system since estimates suggest that more fuel is used in homes than is saved by closing schools; (2) the cost of extending the school day is minimal when viewed in terms of the benefits gained; (3) increased energy costs from extended-day programs are likely to be fully recoverable from increased efficiency in building operation and maintenance; (4) the most energy-efficient use of a building or part of a building is full occupancy; and (5) the school district should cooperate with other public bodies to assure efficient use of energy in all public facilities in the community. (Author/MLF)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED208595

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

CEFP

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ENERGY USE IN COMMUNITY SCHOOLS

A report from the
Council of Educational Facility Planners, International

Published in cooperation with the National Community Education Association and supported, in part, by the Charles Stewart Mott Foundation

EA 014 178

The Council of Educational Facility Planners, International Board of Directors

OFFICERS

Dr. Thomas E. Morgan, President; Professor, School of Education, Auburn University, Auburn, Alabama

Mr. Wendell V. Locke, FAIA, President-Elect; Locke Wright Foster, Oklahoma City, Oklahoma

Mr. C. William Brubaker, FAIA, Past-President; Perkins & Will Architects, Inc., Chicago, Illinois

BOARD MEMBERS

Mr. John Brokaw, AIA, Nixon-Brown-Brokaw-Bowen, Denver, Colorado

Dr. Aane Eriksen, Executive Director, Educational Futures, Inc., Philadelphia, Pennsylvania

Dr. William J. Griffith, Director, Campus Planning, The Ohio State University, Columbus, Ohio

Dr. Barney L. Kyzar, Coordinator of Research, Northwestern State University, Natchitoches, Louisiana

Dr. Milton J. Miller, Director of Educational Facility Planning, Grand Rapids Board of Education, Grand Rapids, Michigan

Mr. D. A. Moir, Head of Planning & Administration, Vancouver School Board, Vancouver, British Columbia

Mr. Harry L. Pelley, Dean, Facilities Planning, Daytona Beach Community College, Daytona Beach, Florida

Dr. Irving M. Peterson, Director of Facility Planning, New Jersey State Department of Education, Trenton, New Jersey

Mr. J. V. Ward, Coordinator, Land & Facilities Planning, San Diego Unified School District, San Diego, California

Mr. A. Eugene Warren, AIA, Wilber, Kendrick, Workman & Warren, Inc., Charlotte, North Carolina

EXECUTIVE DIRECTOR

Dr. Dwayne E. Gardner, Council of Educational Facility Planners, Intl., Columbus, Ohio

Copyright, 1980. The Council of Educational Facility Planners, Columbus, Ohio.

Additional copies of this report are available from CEFP, 29 West Woodruff Avenue, Columbus, Ohio 43210. The full study, from which this report was adapted, is also available at a cost of $10 per single copy.

CONTENTS

Acknowledgments 4
Introduction 5
Chapter 1. The Methodologies 8
Chapter 2. Summary of PSECS Findings 13
Chapter 3. Summary of Buehrer Findings 18
Chapter 4. Practical Applications 25
Chapter 5. Conclusion 28
Glossary 29

ACKNOWLEDGMENTS

The Council of Educational Facility Planners gratefully acknowledges the assistance of Mr. Edmond LeBlanc, for his analysis of the data; Mr. Robert Dorsey, for his statistical analyses; Mr. Huber Buehrer, for his architectural/engineering demonstration methodology; and Dr. William DeJong, Mr. Michael Collins, Ms. Leslie Duffey, Ms. Judith Jenkins and Ms. Mary Boo for developing this publication.

Introduction

The Situation Today

America and the world are faced with an impending energy crisis, primarily due to the dwindling supply of finite fossil fuels upon which most industrialized countries have become so dependent. This threat has been enhanced further by the relative inability of alternative sources of energy to meet demand levels.

These well-publicized facts, combined with other factors such as the spiraling costs for domestic exploration drilling and production; reliance upon increasingly militant third world countries for a majority of our oil supply; inflation and rising fuel prices; long lines at gas stations and the potential of gas rationing, have made all Americans more aware of the unstable nature of the energy situation and their relation to it.

America's vast consumption of energy, approximately 25-30% annually of total world consumption, is not limited to the automobile or to gasoline. All areas of our society—homes, offices, schools, churches, stores—consume energy in one form or another. Demands for energy range from simple appliances and equipment to heating, cooling and lighting systems.

Approximately one-third of all energy used by our nation is consumed in operating buildings. Since educational facilities are our largest group of institutional buildings, energy conservation in schools is a growing concern of both administrators and a budget-minded public.

Background for This Study

During the last few years, especially following the harsh winters of 1976-77 and 1977-78, many schools in the Northeast, Mideast and Midwest regions of our country have closed, or been considered for closing, in efforts to save energy. These actions by school districts and local boards of education generated reports by state education departments in North Carolina and New York that sought to determine the extent of actual savings to school districts and the resultant impact upon school-community programs.

The North Carolina study measured the amount of energy consumed in the school and the surrounding community in five counties during a period when schools were closed because of severe winter weather. The study concluded that 74,736,687 BTUs would have been saved within the total community if the schools had remained open. The net savings of BTUs would probably have been even greater had wood used as fuel been taken into account in the study.

The Board of Regents of the State of New York also set out to determine whether schools should be closed during cold weather. Information on actual energy consumption was collected in 24 school buildings in 10

school districts representing various climate zones in the state. Seven districts also collected data on energy use in the surrounding homes. In addition, data from Educational Facilities Laboratories, Inc. estimated the effect of various school calendars on energy consumption and operation costs for schools.

The Board concluded:

> Closing of school buildings during cold winter months may be counterproductive to total savings of energy. Energy needed for heat, light, and other school operations was found to be somewhat less when schools were closed. This was revealed in the study conducted by Educational Facilities Laboratories, Inc., as well as our own study. Energy consumption, as measured in the homes with children, was somewhat more when schools were closed. Thus, it would seem that closing of schools causes an increase in the use of fuel and electricity in the homes. The data was expanded to represent all buildings and all homes in the sample district. The crude estimate of fuel consumption suggested that more fuel was used in the homes than was saved by closing the buildings.

A preliminary study by the Council of Educational Facility Planners (CEFP) focused on the impact of extended-day activities on a school's overall energy consumption. CEFP wanted to learn how much more energy would be consumed by a school building having a typical extended-day program. This study used simulated extended-day conditions and actual physical data from 247 Ohio schools. The results showed that although additional energy would be consumed when the existing school day was extended, the investment would be cost effective. For each percentage increase in fuel consumption, it was found that building use increased more.

Purpose of This Study

These findings raise larger questions for community educators, school administrators and policy makers who are charged with the responsibility of efficiently administering school facilities or formulating administrative policy. How will energy problems affect present and future programs under their direction? What role should they play in assisting community-wide energy conservation efforts? Are extended use of school facilities and energy conservation interrelated?

This study begins to address these questions. It focuses specifically on the effect of community education programs and extended school facility use on energy consumption. This focus is significant because many school officials, state department personnel, architects and engineers have assumed that considerable energy could be saved by closing schools at 3:00 or 4:00 p.m. (the conclusion of a typical school day). The very

limited research that had been done on the topic, however, raised questions as to the accuracy of this assumption.

The research undertaken here has two areas of emphasis: (1) to assess and analyze the impact on energy consumption of operating school facilities on an extended-day and evening basis compared with not operating school facilities for such periods, and (2) to stimulate intense debate and discussion among community educators, school administrators, boards of education and other interested individuals in an effort to foster a school-community systems perspective for energy conservation decisions.

This study is a beginning. It is hoped it will encourage additional research relative to the impact of extended use of public facilities, particularly schools, on energy consumption. Yet, even if this research generates more questions than it answers, the information it provides should help us to make better energy-conscious decisions for the future.

Note: For the reader's convenience, a glossary is included at the end of this report.

Chapter 1.

The Methodologies

In addressing the question of the impact of extended-day programming on energy consumption in educational facilities, CEFP selected two methods of analysis and two variables for examination by each analysis. The methodologies selected were (1) the computer-based Public School Energy Conservation Service program (PSECS) and (2) the manual methodology developed by Huber Buehrer. The two variables examined by this study were the extended-day program and building occupancy. Each of these methodologies and variables is described below.

PSECS

The Public School Energy Conservation Service is a computer-based energy analysis program developed by Educational Facilities Laboratories, Inc. for the U.S. Federal Energy Administration, the predecessor of the U.S. Department of Energy (DOE).

PSECS is an energy analysis tool designed specifically for public school buildings. It was developed for DOE by design professionals for input by educators. School administrators together with business officials and operation/maintenance personnel provide the PSECS program with a descriptive inventory of academic programming, building characteristics, mechanical and electrical systems and past energy consumption.

Architectural and engineering assumptions based on the state of the art and experience of PSECS developers with school buildings are built into the program. Assumptions and algorithms are applied on a building-by-building basis from input provided by school officials. Analytical results include a projected, or "guideline," annual energy consumption for both electrical and fuel energy in thousands of BTUs per square foot of school building area per year. The "guideline" projections are estimates of what a facility, *as it exists*, "should" consume if operated efficiently. School officials therefore are provided a comparison of actual energy consumption and the PSECS guideline consumption for each school building.

PSECS was never intended to replace an engineer's detailed energy analysis on-site. However, with engineering fees ranging from $.06 to $.12 per square foot of building space and higher, PSECS is a very attractive initial analytical step in the development of school district energy management programs.

PSECS thus provides an evaluation alternative for school officials with limited operating budgets and a lack of on-staff engineers. PSECS results assist school officials in obtaining an overview of actual vs. "guideline" energy consumption across their entire district. As a result, administrators can identify and rank school buildings according to each building's potential for energy reduction. In this way, they can assess their energy

management needs more accurately. School administrators then can effectively allocate operating and capital improvement funds over a period of several years as part of a cost effective energy program. Engineering consultants can be employed to follow up the PSECS analyses with detailed engineering analyses and subsequent retrofit design and installation in accordance with a well thought out, long-term, district-wide energy plan.

In 1977, The Ohio Department of Education began an Energy Auditing Program for Ohio school facilities using the PSECS methodology. Data for approximately 1600 school buildings for the academic years of either 1976-77 or 1977-78 were sent to the State Department by local school officials. The Department reviewed the data prior to submission to the PSECS analysis and examined the resulting PSECS findings for reasonableness.

It was from this initial population that the sample used in the PSECS segment of this study was selected. Complete data were available for 1462 of the nearly 1600 buildings. Data for the other buildings were found to be either incorrect or internally inconsistent or unreasonable. Therefore, the PSECS section of this research is based on an analysis of the input from the 1462 school buildings for which complete data were available.

This study evaluated the effects on these buildings of introducing the prescribed extended-day program variables on two primary PSECS outputs crossed with: (1) projected consumption levels for electric energy usage and (2) projected consumption levels for fuel energy usage. Input data for the 1462 school buildings were changed only to reflect each of the two extended-day variables prescribed. All other input data remained unchanged throughout the analysis.

The Buehrer Method

Just as school districts across the nation operate according to somewhat differing assumptions about education and learning processes, design professionals also perform energy analyses according to differing architectural and engineering assumptions. A second method of energy analysis was useful in evaluating the impact of extended-day conditions on annual school building energy usage.

The second methodology for performing energy analysis that was selected for this study was developed by Mr. Huber Buehrer, a registered architect and registered professional engineer. Mr. Buehrer's methodology, formally called *The Technical Assistance Audit: Estimating Energy Usage*, is one that CEFP has adopted for the purpose of instructing architects and engineers across the nation in the performance of detailed energy analysis of institutional buildings. The Buehrer methodology currently is endorsed by the American Institute of Architects and the National Society of Professional Engineers.

Mr. Buehrer has performed detailed energy analyses using this methodology on a number of buildings including four school buildings in

Ohio, which were chosen for this study. Mr. Buehrer established the "As Is" condition from on-site observation.

The Buehrer method of analyzing a building's energy usage consists of manually determining the annual energy load required in a building's normal operation. It includes calculating energy losses through the building envelope as well as energy used by each mechanical and electrical system in maintaining the required thermal and lighting environments. The Buehrer approach is a developmental methodology. Mr. Buehrer has found, however, that for all cases thus far analyzed, the actual energy consumption is within ±10%, and usually less, of the projected consumption.

Steps in determining a building's energy usage according to the Buehrer method include:

1. Determining Heat Lost Through The Building Envelope Per Degree Hour.
2. Determining Internal Heat Gain By Building Occupants, Lights And Solar Energy.
3. Determining Critical Temperature.
4. Determining Annual Energy Requirements For Heating.
5. Determining Annual Amount of Energy Required to Heat Ventilation Air.
6. Determining Annual Energy Required for Domestic Hot Water.
7. Determining Annual Energy Required for Special Uses.
8. Determining Motor Load.
9. Determining Energy Used for Morning Start-Up.
10. Determining Energy Wasted by Mechanical System.

The Extended-Day Variable

For the purpose of this study, an extended-day condition was defined as one that required a school building to operate its mechanical and electrical systems in the normal occupied mode until 10:00 p.m. on selected weekday evenings and for three daylight hours each weekend during the academic year. The study maintained each building's functional characteristics, envelope characteristics and mechanical/electrical system characteristics as they were reported under normal operation.

Evening operation implies consideration of some differing environmental factors. Not only is there an absence of internal solar gain but the difference between occupied temperature within a building space and the average external temperature is likely to be greater in the evening. Such environmental changes were taken into consideration, but within the context of established operational requirements during normal building occupation. That is, if a temperature of 68°F was established as an existing or guideline condition of building occupancy, 68°F also was maintained during extended-day conditions.

Two extended-day programs were considered for evaluation: (1) four evenings per week and (2) two evenings per week, plus three daylight

hours of weekend operation in each case. Throughout this study, these extended-day programs are referred to as "Extended-day Condition #1" and "Extended-day Condition #2," respectively.

The Building Occupancy Variable

Four levels of building occupancy were considered for evaluation within the context of the two designated extended-day program conditions. These were expressed either as percentage of total building space or as percentage of person occupancy. The two methods of energy analysis (PSECS and Buehrer) used in this study differ in their approach to building occupancy.

The PSECS program employed the following ranges of occupancy levels as percentages of total school building space:

76% — 100%
51% — 75%
26% — 50%
1% — 25%

These figures represent percentages of total available academic area rather than the degree of occupancy of each available space. In special areas, such as a gymnasium or shop, 100% of each space is considered to be in use under all simulated conditions.

The Buehrer methodology kept the amount of space occupied constant and employed the following specific percentages of person occupancy: 100%, 75%, 50% and 25%. If, for example, occupancy of a given area is 50%, the facility is still viewed as using 100% of the space.

Building occupancy was selected as an evaluation variable because it is subject to fluctuation in extended-day programs. Fluctuations in occupancy have an impact on energy consumption in at least two ways, (1) they affect internal heat gained from those individuals, and (2) they affect the percentage of space used, such as the number of classrooms. Use of both the PSECS and Buehrer methodologies provided this study with the capability to examine both types of occupancy fluctuation.

Comments on the Methodologies

Before proceeding, some additional points regarding this research should be emphasized.

- PSECS introduces the dimension of analysis under efficient operating conditions, which Buehrer does not. The Buehrer method, however, provides a more indepth engineering analysis than does PSECS. Since these methodologies differ in their approaches, the reader is cautioned to evaluate the impact of extended-day programming on school building energy consumption *within* either or both methodologies but not *across* methodologies.

- Each methodology described herein is assumed *valid* for the purpose for which it was designed.
- Because there were existing data for 1462 buildings, the PSECS segment of this research was able to provide population trends for that size sample. The cost of applying analysis programs, such as the Buehrer methodology, to a comparable number of school buildings would be monumental and financially prohibitive.
- The PSECS "guideline" energy consumption and the Buehrer "projected" energy consumption are, by definition, *not the same*. The PSECS "guideline" energy consumption is a projection arrived at by adjusting *reported* building operating conditions in accordance with generally accepted operating conditions for maximum efficiency. Identical operating condition adjustments were applied to the "reported" condition and each extended-day condition. Therefore, the resulting projections were estimates of how much energy each building, as it exists, "should" consume if operated efficiently under the "reported" condition and the two simulated extended-day conditions. The Buehrer estimation of annual energy consumption is an estimate of the energy usage under whatever input conditions are observed. Beuhrer does *not* introduce the dimension of efficiency. Modification of operating conditions to achieve increased energy efficiency are left to the building operator and are not inherent in the methodology itself, as in the case of PSECS.

12

Chapter 2.

Summary of PSECS Findings

The PSECS analysis was used to compare energy consumption under each simulated extended-day condition with "guideline" energy consumption under the existing (reported) condition for each building.

Table 1 represents computer projections made from compilation and analysis of the data reported for the 1462 elementary and secondary schools studied. These projections express mean projected energy consumption levels, both electric and fuel energy, in BTUs per square foot per year for each of the eight conditions generated.

Mean square footage for the buildings studied was 57,686 square feet. The buildings ranged from 4,182 sq. ft. to 401,483 sq. ft.

The mean projection for electric energy consumption under existing conditions as reported was 13,871 BTUs per square foot per year. The range for electricity used in the buildings studied was from 1,840 to 91,230 BTUs/sq.ft./yr.

The mean projection for fuel energy consumption under existing conditions as reported was 122,160 BTUs/sq.ft./yr. Fuel energy consumption for the cases studied ranged from 1,400 to 300,000 BTUs/sq.ft./yr.

TABLE 1

Simulated Condition	Mean Projected Energy Consumption Levels: BTUs/per square foot/per year		
	Electricity	Fuel	Total
Reported "guideline"	13,871	122,160	136,031
Extended-Day #1			
76-100% Occupancy	19,181	122,501	141,682
51-75% Occupancy	17,837	122,523	140,360
26-50% Occupancy	16,508	122,545	139,053
01-25% Occupancy	15,180	122,562	137,742
Extended-Day #2			
76-100% Occupancy	16,833	122,350	139,183
51-75% Occupancy	16,084	122,388	138,472
26-50% Occupancy	15,336	122,421	137,757
01-25% Occupancy	14,587	122,454	137,041

Table 2 represents percentages of change (increases) in projected annual energy consumption levels resulting from operation of either extended-day condition under various levels of occupancy. Under PSECS analysis, percentage of occupancy refers to percentage of total space or academic classrooms occupied.

The changes in calculated fuel consumption and electric energy reflect our knowledge of heating, ventilating and air conditioning systems as

embodied in the PSECS methodology. As occupancy, or the percentage of academic classrooms used for extended-day programs, decreases, electric energy consumption also decreases, which is logical because lighting in unoccupied spaces typically is turned off.

As occupancy decreases, fuel energy consumption increases. This is also consistent because elementary and secondary school buildings typically are not equipped with unoccupied space shutoff systems. In other words, all academic classrooms served by a common central heating system usually operate under one of two automatic control conditions, (1) they all operate under a daytime or occupied thermostatic setting or (2) they all operate under the night setback or unoccupied thermostatic setting.

Because most elementary and secondary schools are not equipped with unoccupied space shutoff systems, the PSECS program assumes an "all or none" heating condition for spaces operated by a common or central heating system. This means that, as the percentage of occupancy or the number of classrooms in use decreases, more unoccupied spaces are

TABLE 2

Simulated Condition	Percentages of Change From Reported "Guideline" Condition (Increase projection in annual energy consumption - BTU/sq.ft./yr.)		
	Electricity	Fuel	Total
Extended-Day #1			
76-100% Occupancy	38.25	0.37	4.15
51-75% Occupancy	28.70	0.40	3.18
26-50% Occupancy	19.11	0.42	2.22
01-25% Occupancy	9.50	0.43	1.25
Extended-Day #2			
76-100% Occupancy	21.38	0.26	2.32
51-75% Occupancy	16.03	0.29	1.79
26-50% Occupancy	10.63	0.31	1.27
01-25% Occupancy	5.23	0.34	0.74

being heated at occupied temperatures. Consequently, fuel energy consumption is shown in Tables 1 and 2 to increase as occupancy decreases.

Table 2 indicates that, under Extended-day Condition #1, PSECS analysis projects an increase in electric energy consumption of 38.25% at the 76-100% occupancy level and 9.50% for the 01-25% occupancy level. Fuel energy consumption is projected to increase 0.37% at the 76-100% occupancy level and 0.43% at 01-25% occupancy. Total energy consumption is projected to increase 4.15% at 76-100% occupancy and 1.25% at 01-25% occupancy.

Table 2 also indicates that, under Extended-day Condition #2, PSECS analysis projects increases in energy consumption of 21.38% at 76-100% occupancy and 5.23% at 01-25% occupancy for electricity, and 0.26% at 76-100% occupancy and 0.34% at 01-25% occupancy for fuel. Total energy

consumption under Extended-day condition #2 is projected to increase 2.32% at 76-100% occupancy and 0.74% at 01-25% occupancy.

Upon further examination of percentage increases reported in Table 2, it was noted that these increases were considerably smaller than those that resulted from a preliminary CEFP study. The researchers were curious as to why such reduced increases occurred in moving from the initial 247 school buildings studied to the expanded population of 1462 buildings. It was suspected that various sub-populations were influencing the generation of population means.

The researchers proceeded to examine the data building by building. Two sub-populations emerged and it was determined that each was producing opposite effects on the generation of overall population means. That is, while some school buildings operating under simulated extended-day conditions at 76-100% occupancy increased fuel energy consumption from the projected "guideline" condition, other buildings actually consumed less fuel energy. It was believed that these two opposite effects resulted in reduced overall means when combined mathematically.

The researchers then conducted a cursory examination of each of these two sub-populations of school buildings. It was found that the mean reported "guideline" fuel energy consumption was 168,257 BTUs per square foot per year for the 429 school buildings in which extended-day conditions at 76-100% occupancy resulted in lower fuel energy consumption. The 1033 buildings in which fuel energy consumption increased generated a mean reported "guideline" fuel energy consumption of 103,019 BTUs per square foot per year.

These results indicate *the need for a more detailed study of each of these two sub-populations of school buildings*. Operating conditions are not predicted to be an influencing factor since the PSECS program assumes the condition of efficiency. The researchers, however, have isolated two possible factors that may be determinants in whether a school building increases or decreases fuel energy consumption under an

TABLE 3

Ranges of percentage of increase in **electric** energy consumption experienced by 68% of the school buildings studied when reported "Guideline" occupancy conditions were changed to simulated extended-day occupancy conditions.

	Ranges	
	Low	High
4-Day, Extended-Day		
76-100% Occupancy	31.29%	59.95%
51-75% Occupancy	23.16%	45.43%
26-50% Occupancy	15.24%	30.71%
01-25% Occupancy	7.49%	15.48%
2-Day, Extended-Day		
76-100% Occupancy	17.02%	34.80%
51-75% Occupancy	12.60%	26.35%
26-50% Occupancy	8.27%	17.68%
01-25% Occupancy	3.98%	8.83%

extended-day condition. These are (1) *a building's physical characteristics* and (2) *its occupied critical temperature*. Further study is recommended to determine which physical characteristics, or combination of physical characteristics, influence fuel energy consumption, and how, and what influence occupied critical temperature elements have on fuel energy consumption. (Critical temperature is discussed further in Chapter V of this report.)

When we consider the 1462 school buildings statistically, we also can look at those cases (68%) that fall within ±1 standard deviation of the mean. For this study, that represents approximately 994 school buildings.

Tables 3, 4 and 5 represent ranges of percentage change in electric and fuel energy consumption that are projected to occur in those 994 cases.

TABLE 4

Ranges of percentage of change in **fuel** energy consumption experienced by 68% of the school buildings studied when reported "Guideline" occupancy conditions were changed to simulated extended-day occupancy conditions.

	Ranges	
	Low	High
4-Day Extended-Day		
76-100% Occupancy	-2.15%	+4.01%
51-75% Occupancy	-0.92%	+3.29%
26-50% Occupancy	-0.58%	+2.52%
01-25% Occupancy	-0.23%	+1.20%
2-Day Extended-Day		
76-100% Occupancy	-0.81%	+2.54%
51-75% Occupancy	-0.59%	+2.11%
26-50% Occupancy	-0.37%	+1.65%
01-25% Occupancy	-0.15%	+1.19%

TABLE 5

Ranges of percentages of increase in **total** energy consumption experienced by 68% of the school buildings studied when reported "Guideline" occupancy conditions were changed to simulated extended-day occupancy conditions.

	Ranges	
	Low	High
4-Day Extended-Day		
76-100% Occupancy	2.27%	8.90%
51-75% Occupancy	1.68%	6.98%
26-50% Occupancy	1.12%	4.99%
01-25% Occupancy	0.60%	2.91%
2-Day Extended-Day		
76-100% Occupancy	1.11%	5.36%
51-75% Occupancy	0.83%	4.23%
26-50% Occupancy	0.56%	3.06%
01-25% Occupancy	0.30%	1.86%

These ranges are provided to give the reader a better picture of the degree of change that might be expected from the introduction of increased school building occupancy under an extended-day condition.

The reader is cautioned to keep in mind that these ranges were generated from data reported for 1462 school buildings in the State of Ohio analyzed by the PSECS energy analysis program, which assumes energy efficiency. Different climate conditions and/or less efficient operating conditions within comparable periods of building occupancy can result in quite different percentages of change relative to energy consumption.

The prediction that individual building characteristics and occupied critical temperatures may be factors determining why fuel energy consumption decreased in some buildings and increased in others is based on virtually identical ranges in reported "Guideline" energy consumption for both sub-populations.

The PSECS findings thus lead to a recommendation for continued study of the impact of extended-day conditions on energy consumption not only to gain additional information to assist extended-day programming decisions but also to identify factors that may have a significant impact on that information (i.e., critical temperature and/or specific physical characteristics).

Chapter 3.

Summary of Buehrer Findings

Critical Temperature Factor

As a result of analyzing four buildings in this study by the Buehrer methodology, a potentially significant factor for administrative decision making was identified. That factor is occupied "critical temperature."

Critical temperature as a concept is not totally new. The calculation that results in what is herein defined as critical temperature is one of many engineering calculations performed to determine a building's energy usage. Critical temperature is, in essence, the point at which internal heat gained from occupants, lighting and solar energy balances heat lost through the building envelope.

The findings from the four Ohio buildings analyzed by the Buehrer methodology indicate that when the occupied critical temperature is less than the desired unoccupied temperature, less space heating is required for occupancy than otherwise would be required if the facility were unoccupied.

This finding is significant because it implies that if there is a direct relationship between critical temperature and energy required for space heating, school officials should be able to predict the effect of extended-day programs on energy consumption by knowing a building's critical temperature.

Though there is not, as yet, an easy method for determining a building's critical temperature—it would require an engineering analysis—it is hoped that such a method would be developed fostered by the findings of this study. School officials would then have a simple way to assess whether or not it would be cost effective to occupy a school building.

Since critical temperatures may be so significant, the following examples are provided to assist the reader in understanding the concept.

Example #1

(a) The critical temperature of the building is 40°F (as determined by evaluating internal heat gain from occupancy, lighting and solar energy at a specified temperature setting, i.e., 68°F).

(b) If occupied, no fuel energy for space heating will be required until the outside temperature drops below 40°F.

(c) If unoccupied, the building does not benefit from the critical temperature effect. Therefore if the building has an unoccupied temperature setting (i.e., 55°F), fuel energy for space heating would be required whenever the outside temperature falls below 55°F.

(d) This example implies that less fuel energy for space heating would be required to occupy this building at a 68°F setting than would be required if the building were unoccupied at a 55°F setting. Depending on electric energy change/cost, it actually may be less expensive to keep the facility open and occupied than to maintain it unoccupied.

Example #2

(a) The critical temperature of the building is 60°F (68°F occupied setting as #1).
(b) If occupied, fuel oil would not be required until the outside temperature falls below 60°F.
(c) If unoccupied, fuel oil would not be required to maintain an unoccupied setting of 55°F until the outside temperature falls below 55°F.
(d) This example implies that it would be more cost effective to have this facility unoccupied if the temperature was less than 60°F.

An additional benefit may result from the isolation of the critical temperature factor. In cases where an occupied building's critical temperature was calculated to be greater than its unoccupied space temperature, an analysis of the elements comprising critical temperature may provide guidance as to energy conservation measures that could be taken to reduce the building's critical temperature. This would assist school officials to use energy more effectively and, at the same time, help to make the building more energy efficient overall.

As significant as the critical temperature factor may be, it only emerged in the Buehrer analysis of four school buildings. Four cases represent an insufficient sample from which to generalize to a larger population of school buildings. Further research is needed to determine whether critical temperature independently is a significant factor for assessing the impact of extended-day programming on energy consumption.

Major Buehrer Findings

In the four schools under study, it was found that, where critical temperatures were lower than unoccupied temperatures, less fuel energy was used for space heating than during the "As is" condition.

Considering averages of the percentages of change in each of the four schools, annual fuel energy usage for space heating increased from 0.7% to 3.0% during the four-day extended-day condition and from 0.1% to 1.2% for the two-day extended-day condition.

Averaging percentages of change by school organization (i.e., secondary vs. elementary) indicated a lower increase in annual fuel energy usage for space heating in the secondary schools than in the elementary schools.

In *total annual fuel energy usage* this study indicated an overall increase from a low of 2.9% to a high of 12.4% during the four-day extended-day conditions. Comparable increases ranged from a low of 1.4% to a high of 6.2% during two-day extended-day conditions.

Averaging percentages of change across all four schools in this study resulted in an increase in total annual fuel energy usage from 4.5% to 7.0% and from 2.2% to 3.4% for four-day and two-day extended-day conditions, respectively.

Taking school organization into consideration, the secondary schools experienced a greater increase in total annual fuel energy usage, from 5.5% to 7.6% (four-day extended-day) and from 2.8% to 3.7% (two-day extended-day), than the elementary schools, from 3.5% to 6.5% (four-day extended-day) and 1.6% to 3.0% (two-day extended-day).

In *total annual electric energy usage* there was an overall increase from a low of 17.3% to a high of 57.9% during four-day extended-day conditions. Comparable increases ranged from 8.8% to 28.0% during two-day extended-day conditions. Electric energy uses for any purpose other than space heating were maintained as constants.

Averaging percentages of change across all four school buildings under study resulted in an average increase in total annual electric energy usage of 37.5% under four-day extended-day conditions and 18.9% under two-day extended-day conditions.

Differences in school organization appeared to have little effect on electric energy usage increase. Secondary and elementary schools under study appeared to increase electric energy usage equally under both extended-day conditions.

TABLE 6
Total Annual Energy Requirements
Percentages of Change / 4-Day Extended Day Program

Variable	OCCUPANCY 100%	75%	50%	25%
School #1 (71.4% increase in Building Utilization)	14.2	14.8	15.4	16.1
School #2 (71.4% increase in Building Utilization)	12.4	12.9	13.4	13.8
School #3 (76.9% increase in Building Utilization)	9.4	10.1	10.9	11.6
School #4 (76.9% increase in Building Utilization)	6.2	7.1	7.9	9.0
Averages:				
Total	10.6	11.2	11.9	12.6
Secondary	13.3	13.9	14.4	15.0
Elementary	7.8	8.6	9.4	10.3

Tables 6 and 7 summarize percentages of change in *total annual energy usage* for all four school buildings studied under each extended-day condition. Generally, increases in total annual energy usage ranged from a

low of 6.2% to a high of 14.8% under four-day extended-day conditions, and from a low of 3.0% to a high of 8.2% under two-day extended-day conditions.

Averaging percentages of change across all four school buildings under study resulted in an average increase in total annual energy usage of from 10.6% to 12.6% under four-day extended-day conditions, and from 5.3% to 6.2% under two-day extended-day conditions.

TABLE 7
Total Annual Energy Requirements
Percentages of Change / 2-Day Extended Day Program

Variable	OCCUPANCY 100%	75%	50%	25%
School #1 (40% increase in Building Utilization)	7.4	7.6	8.0	8.2
School #2 (40% increase in Building Utilization)	6.3	6.5	6.8	6.9
School #3 (43.1% increase in Building Utilization)	4.4	4.8	5.2	5.5
School #4 (43.1% increase in Building Utilization)	3.0	3.5	3.8	4.3
Averages:				
Total	5.3	5.6	6.0	6.2
Secondary	6.9	7.1	7.4	7.6
Elementary	3.7	4.2	4.5	4.9

School organization did seem to make a difference in *total annual energy usage* under extended-day conditions. In the secondary schools studied, total annual energy usage increased from 13.3% to 15.0% and from 6.9% to 7.6% under each extended-day condition, respectively. However, in the elementary schools, total annual energy usage only increased from 7.8% to 10.3% and from 3.7% to 4.9% under each extended-day condition, respectively.

Annual energy requirements under extended-day conditions also should be evaluated from the perspective of increased building use. Under four-day extended-day conditions, the secondary schools studied increased building use by 71.4% while the elementary schools experienced a 76.9% increase in building use. Under two-day extended-day conditions, resulting increases in building utilization were 40% for the secondary schools and 43.1% for the elementary schools.

Therefore, final evaluation of extended-day programs should include an examination of the relationship of benefits to costs. Benefit/cost analysis is an economic analysis that provides a numeric representation of the relationship and value of benefits (in this case, energy savings and/or

increased building usage) vs. costs (increased consumption of energy dollars). A benefit/cost ratio greater than one (more than one dollar returned on each dollar invested) represents a cost-effective investment.

Benefit/cost ratios of increased building utilization to increased energy consumption for the secondary schools ranged from 5.4:1 (71.4 ÷ 13.3) to 4.8:1 (71.4 ÷ 15.0) under four-day extended-day conditions and from 5.8:1 (40 ÷ 6.9) to 5.3:1 (40 ÷ 7.6) under two-day extended-day conditions. For the elementary schools benefit/cost ratios ranged from 9.9:1 (76.9 ÷ 7.8) to 7.5:1 (76.9 ÷ 10.3) under four-day extended-day conditions and from 11.7:1 (43.1 ÷ 3.7) to 8.8:1 (43.1 ÷ 4.9) under two-day extended-day conditions.

A benefit/cost ratio of 11.7:1, for instance, means that each BTU of energy invested in extended-day programming returns 11.7 times that cost in benefits resulting from increased use of the school building.

Tables 8 and 9 show that the simulated extended-day programs reduced the amount of energy needed to support each hour of occupation in the school buildings under study. That is, the extended-day programs reduced energy being wasted in the heating of the buildings when unoccupied.

For School #2, introduction of the four-day extended-day program alone decreased the number of degree hours of heating required during unoccupied hours by 17.3%. Alternately, 36% of fuel energy used for space heating was then consumed during occupied hours thereby decreasing the percentage of fuel energy used to heat School #2 when occupied.

TABLE 8

Total Annual Energy Requirements to Support Each Hour of School Building Occupation

Percentages of Change Per Occupied Hour/ 4-Day Extended Day Program

	OCCUPANCY			
Variable	**100%**	**75%**	**50%**	**25%**
School #1	-29.9	-29.6	-28.9	-28.6
School #2	-30.8	-30.6	-30.4	-30.0
School #3	-34.6	-34.6	-34.1	-33.7
School #4	-40.3	-39.5	-38.7	-38.7
Averages:				
Total	-33.9	-33.6	-33.0	-32.8
Secondary	-30.4	-30.1	-29.7	-29.3
Elementary	-37.5	-37.1	-36.4	-36.2

If an effective BTU of fuel energy used for space heating is defined as one that is consumed to heat a fully occupied space, we have a measure of effectiveness of energy used for space heating. Tables 10 and 11 present changes in effectiveness of fuel energy used for space heating under the designated extended-day conditions.

In the generation of Tables 10 and 11, energy required for additional evening occupation at 100% occupancy was used as the numerator for all extended-day conditions. The respective total amount of energy used for space heating in each case constituted the denominator. These tables serve as measures of increased effectiveness of energy used for space heating as a result of the extended-day conditions.

There are 168 hours in every week. Yet, the four school buildings under study operated for only 32.5 and 35 hours per week in the "As Is" condition. This translates into typical school building utilizations of 19.3% and 20.8%.

TABLE 9

Total Annual Energy Requirements to Support Each Hour of School Building Occupation

Percentages of Change Per Occupied Hour/ 2-Day Extended Day Program

	OCCUPANCY			
Variable	**100%**	**75%**	**50%**	**25%**
School #1	-34.1	-33.8	-33.8	-33.4
School #2	-19.1	-18.8	-18.6	-18.6
School #3	-22.1	-21.6	-21.6	-21.2
School #4	-28.2	-27.4	-27.4	-27.4
Averages:				
Total	-25.9	-25.4	-25.4	-25.2
Secondary	-26.6	-26.3	-26.2	-26.0
Elementary	-25.2	-24.5	-24.5	-24.3

When outside temperatures drop below the designated unoccupied temperatures of 55°F and 62.5°F, energy for space heating is added to each building. In a northern state like Ohio this means that heat energy usually will be added to the unoccupied school buildings for 80.7% and 79.2% of a typical week for approximately six months of every year. That is, for 135.5 and 133 hours of every week for six months of every year, ***energy is being consumed to heat an unoccupied building.***

This addition of energy to an unoccupied school building is solely to support 32.5 and 35 hours of building occupation. School #2, for instance, consumed 2,660,000 BTUs of fuel energy for space heating just to support each hour that it was occupied during the year.

Without performing a single energy conservation measure, the increased occupancy resulting from the four-day extended-day program under study reduced the fuel energy for space heating needed to support each hour of occupation to 1,700,000 BTUs.

Only 19.5% of fuel energy used for space heating in School #2 was consumed during occupied hours in the "As Is" condition. The remaining 80.5% of fuel energy for space heating was required during unoccupied hours. The reader will note that these percentages correspond very closely with building utilization percentages presented earlier.

Tables 10 and 11 indicate an average increase in effectiveness of energy used for space heating in all four school buildings from 14.6% to 14.3% under the four day extended day program and 7.3% under the two day extended day program. The elementary schools appeared to have a higher increase in energy effectiveness. [Energy effectiveness should be distinguished from energy efficiency. This study addressed the effective use of energy rather than its efficient use. Energy efficiency refers to full utilization of each BTU as it is consumed. Energy effectiveness, as defined herein, refers to appropriate use of each BTU.]

School buildings are constructed for the purpose of human occupation. Every BTU of energy consumed when a school building is not being used for human occupation might be said to be used ineffectively. Tables 10 and 11 suggest that the extended day programs under study contribute to increased energy effectiveness.

TABLE 10

Percentages of Change in Effectiveness of Fuel Energy Used for Space Heating: 4-Day Extended Day Program

	OCCUPANCY			
Variable	**100%**	**75%**	**50%**	**25%**
School #1	10.8	10.7	10.6	10.6
School #2	16.7	16.6	16.6	16.5
School #3	16.2	16.1	15.9	15.8
School #4	14.7	14.5	14.4	14.2
Averages:				
Total	14.6	14.5	14.4	14.3
Secondary	13.8	13.7	13.6	13.6
Elementary	15.5	15.3	15.2	15.0

TABLE 11

Percentages of Change in Effectiveness of Fuel Energy Used for Space Heating: 2-Day Extended Day Program

	OCCUPANCY			
Variable	**100%**	**75%**	**50%**	**25%**
School #1	8.5	8.5	8.5	8.5
School #2	5.3	5.3	5.2	5.2
School #3	8.2	8.1	8.1	8.1
School #4	7.3	7.3	7.3	7.2
Averages:				
Total	7.3	7.3	7.3	7.3
Secondary	6.9	6.9	6.9	6.9
Elementary	7.8	7.7	7.7	7.7

Chapter 4.

Practical Applications

Planning an effective energy management program for community education must be a cooperative effort based on reliable information. A first step is a thorough energy audit, including supply records and calculations of future demands. The end product of the study should be a range of management options and implementation strategies.

Listed below are some important considerations in the development of a comprehensive energy management program.

1. ***The school and the community should be viewed as a single energy-use system.***

Efforts directed at energy conservation should not be focused on individual facilities or specific programs in isolation. A broader societal approach should be taken. If a school facility and its surrounding community are seen as a single energy-use system, the interdependencies critical to energy conservation efforts are obvious. An individual school's energy consumption is intricately linked with the total community's energy consumption as well as with a number of other factors, including school building use, total system cost effectiveness, and total system energy efficiency.

Decisions that appear to decrease energy consumption in one element of an energy-use system may, in fact, cause an increase in energy consumption in the system as a whole. For example, when schools are randomly closed or extended-day activities curtailed in cold weather, reduction of school energy consumption is very likely to be offset by increases in energy consumption within the surrounding community. This was found to be the case in both North Carolina and New York, according to the results of studies cited in the Introduction of this report.

Logic alone tells us that supplying the energy needs of, say, 75 homes that would be vacated during activities at the school site would be more costly than heating and lighting three school classrooms or one auditorium. Further, loss of residual building heat from day-time or extended-day occupancy would obviously increase warm-up costs each morning. Even an unoccupied building consumes energy to prevent freeze-up, and 100 percent of this energy may be said to be wasted if no service to the community takes place.

2. ***The cost of extending the school day is minimal when viewed in terms of the benefits gained.***

The PSESC studies, for example, show that fuel energy consumption from extending the school day would increase only 1.5 to 3.2 percent overall, while increasing use of the school facility from 38 percent (increasing from 40 hours to 55 hours per week) to 68 percent (increas-

Chapter 5.

Conclusion

A primary task for educational leaders is to develop ways in which citizens can identify and describe their own education needs in order to develop a unified and cooperative plan of action. For educators whose programs will be directly affected by energy decisions, the need, then, is clear. They should:

- Become thoroughly informed.
- Seek involvement for themselves.
- Assure the widest possible participation by all interested parties.
- Assist in the search for solutions based on a school-community perspective.

Specific activities might include:

- Developing advisory committees for the specific purpose of generating a community energy conservation plan.
- Offering courses and seminars in energy conservation for community residents.
- Publishing energy-related newsletters, brochures, and pamphlets.
- Acting as a clearinghouse for energy-related information.
- Developing a resource directory of agencies involved in energy conservation.

Those who are responsible for formulating community education policies and administering community education programs will increasingly find that their decisions are affected by energy concerns. They will be ill-advised and the public ill-served if these decisions are made by a select few on the basis of myths and surmises. Wise decisions will be made only by well-informed citizens working together for the benefit of the entire community.

Glossary

"As Is" Condition: Term used in Buehrer analysis to describe the condition of the building as it existed at the time of on-site observation.

Benefit/Cost Ratio: The ratio of benefits (in this case, increased facility use or energy savings) to cost (in this case, energy consumption). Whenever that ratio is greater than 1:1, in economic terms a program is said to be cost effective.

British Thermal Unit (BTU): The quantity of heat required to raise the temperature of one pound of water from 62° F to 63°F. A BTU is small and is approximately the amount of energy given off by a large wooden match. School districts buy energy in various forms and in different units. When a school buys a unit of electricity, or oil, or natural gas, it is buying the "ability to do useful work" not the unit itself. The common measure of this ability is the B.T.U.

Form of Energy	BTUs
1 Kilowatt-Hour	3,413
1 Pound of Steam	1,000
1 Ton of Coal	25,000,000
1 Barrel of Oil	5,800,000
1 Gallon of Gasoline	125,000
1 Gallon #2 Fuel Oil	140,000
1 Gallon #6 Fuel Oil	149,000
1 Mcf. of Natural Gas	1,032,000
1 Gallon of LPG	95,475
1 Therm of Gas	100,000
1 Cord of Wood	20,000,000

Building Envelope: The outside structure of the building—i.e., the walls, windows, roof, floor, and skylights.

Critical Temperature: Name given by the researchers in this study for the engineering point at which internal heat gain (from occupancy, thermostat setting, lights, etc.) balances heat loss through the building envelope. A critical temperature of 50°F, for example, means that internal heat gain will offset heat loss until the

outside temperature drops below 50°F. Until the temperature drops below 50°F, no heat is required from the mechanical system for space heating other than for any initial morning warm-up.

Degree Hour: A degree hour is a temperature difference of one degree for a time span of one hour. The number of degree hours above and below any given temperature can be calculated from data provided by the National Oceanographic and Atmospheric Administration.

Existing (reported) Condition: In the PSECS methodology, the condition of the building reported by local school officials.

Extended-day Condition #1: A simulated condition developed for this study wherein an educational facility is in operation from 4:00-10:00 p.m. four nights per week and from 9:00 a.m.-12:00 noon on Saturday.

Extended-day Condition #2: A simulated condition developed for this study wherein an educational facility is in operation from 4:00-10:00 p.m. two nights per week and from 9:00 a.m.-12:00 noon on Saturday.

Extended-Day Programming: Utilization of facility beyond, and including, typical K-12 programs. For example, if a school facility is utilized seven hours a day (Monday-Friday) for K-12 programs and an additional four hours a day (Monday-Saturday) for community education, extra-curricular activities and other programs, the facility would be said to be programmed for utilization 59 hours per week.

Heating Degree Hours: Heating degree hours are the number of degree hours below the critical temperature or the unoccupied temperature in which heating is required by a building's mechanical systems. Cooling degree hours are the number of degree hours above a given temperature.

(per) Hour Energy Consumption: Total amount of energy needed to support one hour of facility utilization (occupied).

Hour of Occupation: Each hour the facility is utilized for programs.

Occupied Temperature: This is the temperature maintained within a building by the building operator during periods when the building is being occupied.

Unoccupied Temperature: This is the temperature maintained in the building by the building operator during periods when the building is not being occupied.

ing from 40 hours to 67 hours per week). For each percentage increase in fuel consumption, building use was increased much more, indicating a very effective investment.

In the Buehrer study, extended-day programs were shown to reduce the per-hour cost of operation; again, increased building use (the benefit) was greater than the cost (increased energy consumption).

3. ***Increased energy costs from extended-day programs are likely to be fully recoverable from increased efficiency in building operation and maintenance.***

Maximizing a building's energy efficiency during each hour of operation is a much more effective way to achieve overall energy efficiency than simply reducing the number of hours of operation.

From 20 to 40 percent of the energy consumed in providing education and social services is likely to be wasted because the buildings are being underused or because the energy used is being mismanaged. Reducing services alone would in no way decrease that waste.

There are many energy conservation opportunities in school buildings. Secondary schools (grades 7-12) should conform to the *Emergency Building Temperature Restrictions* of the Department of Energy:

- Thermostats must be set no higher than 65°F for heating during periods of occupany.
- Thermostats must be set no lower than 78°F for cooling.
- Thermostats must be set no higher than 55°F for heating during unoccupied periods (nights, weekends, holidays).
- Hot water thermostats must be set no higher than 105°F for domestic use.

Efforts should be made to resist the flow of heat through walls, roofs, windows, and doors. Measures that should be considered are:

- Insulation.
- Lowering of ceilings.
- Weatherstripping, caulking.
- Reduction of glass area with panels or multiple glazed windows.
- Addition of vestibules.
- Control of traffic flow through doors.

Many energy experts believe that energy consumption in a typical school building can be reduced by 20 percent or more from operation and maintenance changes alone. Both the PSECS and Buehrer studies indicate that any increases from extended-day programming can be paid for several times over through those changes. Capital expenditure modifications to a building will result in further reductions.

4. ***The most energy-efficient use of a building or part of a building is full occupancy.***

Every heated and lighted space not occupied or not occupied to capacity detracts from an occupied building's overall efficiency. Empty

classrooms, or school spaces that are unnecessarily large for the activities assigned to them, are obvious examples of inefficient use of an occupied building. For example, adding senior-citizen activities or a pre-school program in an unoccupied area during normal operations would not increase heating costs and would increase overall energy efficiency.

Using the residual heat from the regular school day to conduct after-school programs is another example of energy efficiency. And keeping the building warm until 9 or 10 in the evening (residual heat will keep the building comfortable for a period of time after the heat is actually shut down) will reduce early morning warm-up costs. Once energy efficiency is clearly identified as a goal, many other applications will be found.

5. ***The school or school district should cooperate with other public bodies to assure efficient use of energy in all public facilities in the community.***

The need for cooperation is clear:

- Duplication of services is expensive and inefficient.
- Civic cooperation is preferable to competition.
- Many public services are interrelated.
- The opportunities for public participation are enhanced when several agencies plan cooperatively.